INSTRUCTIONS WITH PARTS LIST

WESTON®

1241 DIGITAL VOLT-OHMMETER

TRLR

INSTRUCTIONS WITH PARTS LIST

FOR

SHOP COPY

WESTON® MODEL 1241 DIGITAL VOLT-OHMMETER

CONTROLLED DOCUMENT

U. S. Patent 3,051,939

Copyright 1970 by

WESTON INSTRUMENTS DIVISION
WESTON INSTRUMENTS, INC.
614 FRELINGHUYSEN AVENUE, NEWARK, N. J. 07114
a Schlumberger company

F-3623 © 1/70

Printed in U.S.A.

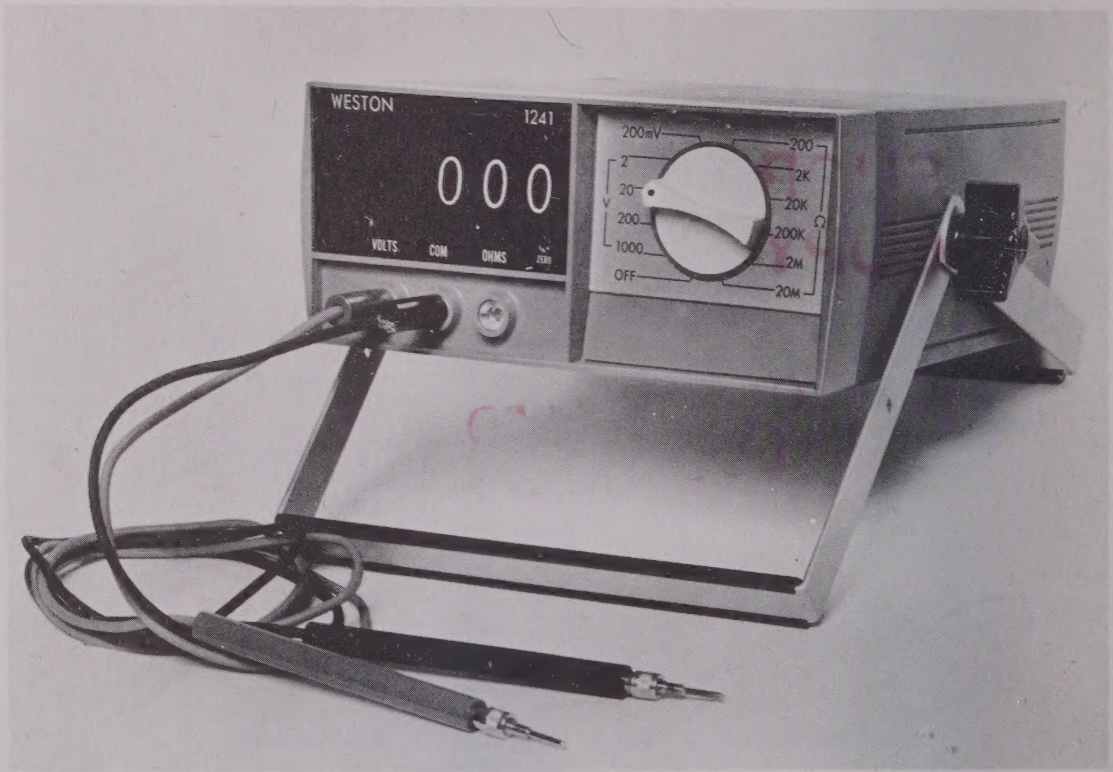

Figure 1. Model 1241 Digital Volt Ohmmeter with Handle/Stand and Test Probes

TABLE OF CONTENTS

SECTION	PAGE NO.
GENERAL INFORMATION	1
DESCRIPTION	1
SPECIFICATIONS	1
DC VOLTS	2
RESISTANCE	2
INSTALLATION	3
GENERAL	3
CARRYING HANDLES	3
TILT-STAND OPERATION	3
PANEL MOUNTING	3
BATTERY PACK OPTION	5
POWER REQUIREMENTS	5
OPERATION	6
FRONT PANEL DESCRIPTION	6
INPUT OVERLOAD PROTECTION	7
REAR PANEL DESCRIPTION	8
DC VOLTAGE MEASUREMENT	9
OHMS MEASUREMENT	10
THEORY OF OPERATION	11
INTRODUCTION	11
DETAILED CIRCUIT DESCRIPTION	11
DC VOLTMETER CIRCUIT	11
DUAL SLOPE A/D CONVERSION	11

SECTION	PAGE NO.
THEORY OF OPERATION (Con't)	
DC VOLTMETER LOGIC SECTION	13
Synchronization	13
Polarity Display	13
Reference Current Control	15
Zero Crossing	15
Readout Command	15
DC VOLTMETER-ANALOG SECTION	15
The Non-Inverting Integrator	16
Offset Adjustment	16
Input Attenuation	16
Reference Current Circuits	18
OHMS CONVERSION	18
POWER SUPPLY	19
MAINTENANCE	21
TEST EQUIPMENT REQUIRED	21
PERFORMANCE CHECK	22
DC VOLTAGE ACCURACY CHECK	22
RESISTANCE ACCURACY CHECK	23
CALIBRATION	24
SCHEMATIC DIAGRAMS AND ASSEMBLY DRAWINGS	25
PARTS LIST	31

LIST OF ILLUSTRATIONS

FIGURE		PAGE NO.
1	Model 1241 Digital Volt Ohmmeter with Handle/ Stand and Test Probes	A
2	Handle/Stand Assembly	4
3	Panel Cut-out Dimensions...	4
4	Removal of Front Assembly using Handle/Stand as Fulcrum	4
5	Panel Mounting (Optional) ..	4
6	Front Panel Description	6
7	Input Fuse Replacement	7
8	Rear Panel Description	8
9	DC Voltage Measurement ...	9
10	Ohms Measurement	10
11	Waveforms	12
12	Block Diagram	14
13	Integrator Circuit	16
14	Input Attenuation	17
15	Offset Adjustment	18
16	Reference Current Circuit	18
17	Ohms Conversion Circuit .	20
18	Calibration	24
19	Method of Assembly	26
20	Board Assembly.....	27
21	Schematic Analog Section..	28
22	Schematic Logic Section ..	29
23	Schematic Power Supply ..	30

GENERAL INFORMATION

DESCRIPTION.

The Weston Model 1241 is a compact digital volt ohmeter designed for maximum operator convenience and utility. Five DC voltage ranges and six resistance ranges are self-contained in a high-impact resistance plastic case.

The basic measuring circuit is a high impedance bipolar analog to digital converter which employs dual-slope integration to achieve excellent accuracy and long term stability. The basic measurement ranges and 200 millivolts and 2 volts DC at an accuracy of ±0.1% of reading ±0.05% of full scale. All other ranges and functions are converted to one of these basic ranges for measurement as a DC voltage.

A custom-designed thin-film attenuator extends DC voltage measurements to 1000 volts with a voltage coefficient less than 100 parts per million at 1000 volts. Overrange capability permits useful readings of DC voltage of at least 50% beyond the inherent 2000 bits.

Resistance is measured by passing a scaled constant current through the unknown and measuring the DC voltage across it. Resistance ranges from 200 ohms to 20 megohms are provided with a measuring current of no more than 1 milliampere (at the 200 ohm range).

The mechanical design of Model 1241 has stressed operator convenience and confidence in its straight-forward control/connector layout and full overload protection. Easy portability is evident, too, in its small size, fully recessed controls, and connectors, and its battery pack compatibility for field use.

Carrying handles serve a dual purpose as a tilt-stand for any viewing angle during table top operation. The instrument may be panel mounted without any additional parts.

Optional accessories include a battery pack capable of over 6 hours of continuous field operation and overnight recharge, and a leather carrying case.

Power requirements are 115 VAC or 230 VAC at frequencies of 50/60/400 Hz.

SPECIFICATIONS

Size:	3" high x 7" wide x 7.9" deep
Weight:	Approx. 4 pounds (1.9Kg)
Display:	Maximum Count: 1999 Overrange Indication: Automatic beyond 1999 Polarity Indication: Automatic "+" or "-" Reading Rate: 5 per second, non-blink (200 millisec integration time). Numeric Display by side-viewing neon glow tubes with integral decimal points
Power Requirement: ..	115 VAC or 230 VAC Tolerance: +15%, -10% Line Frequency: 50Hz to 400Hz Power Drain: 6.0 watts, nominal

SPECIFICATIONS (Continued)

Accessories: .... Combination carrying handle tilt stand - standard on all units
Battery Pack - optional
Leather carrying case - optional

Additional Features: ..... All fuses accessible from outside of unit. May be operated 500 volts above power line ground

Operating Temperature: ... 10°C to 40°C
Reference: 25°C ±1°C

DC VOLTS

Range	Zin	Rated Accuracy	Overload Protection
200mV	≥100MΩ	±0.1% rdg. ±1 digit	350V
2V	≥1000MΩ	±0.1% rdg. ±1 digit	350V
20V	10MΩ	±0.1% rdg. ±1 digit	1000V
200V	10MΩ	±0.1% rdg. ±1 digit	1000V
1000V	10MΩ	±0.1% rdg. ±1 digit	1000V

Overrange Capability: ..... 20% minimum (subject to overload protection limits)

Resolution: ..... 100 microvolts

Full Scale Step Response: .. 2 seconds to rated accuracy

Input Bias Current: ..... 10 na maximum at reference conditions

Temperature Influence: ..... ±0.005% rdg/°C ±0.1 digit/°C

Normal Mode Rejection: ..... 35 db minimum at 60 Hz

Common Mode Rejection: ..... 80 db minimum with 1K unbalance at 60 Hz. Can be operated on batteries for extended CMRR

RESISTANCE

Range	Test Current	Rated Accuracy	Overload Protection
200Ω	1 MA	±0.5% rdg. ±1 digit	250V RMS*
2K	100 μa	±0.5% rdg. ±1 digit	250V RMS*
20K	10 μa	±0.5% rdg. ±1 digit	250V RMS
200K	10 μa	±0.5% rdg. ±1 digit	250V RMS
2M	1 μa	±0.5% rdg. ±1 digit	250V RMS
20M	100 na	±1% rdg. ±1 digit	250V RMS

Resolution: ..... 0.1 ohm

Full Scale Step Response: .. Two seconds on ohm and K ohms ranges; 6 seconds at 10 megohms

Temperature Influence: ..... ±0.05% rdg/°C ±0.1 digit/°C

Overrange Capability: ..... 20% minimum

*by fuse and clamp diodes

INSTALLATION

GENERAL

Inspect the instrument for possible damage in shipment. If damage is noted, notify the carrier and supplier before using the instrument.

CARRYING HANDLES

Remove the carrying handles and knobs from the accessory container. Mount handles to the case as shown in Figure 2. The knobs differ at their threaded ends and may be used on either side of the case. When oriented for carrying both handles should be rotated to the front of the case, at which point their detents will lock and may be secured by tightening the knobs.

TILT-STAND OPERATION

For bench or table top use, the handles should be locked in the open position shown in Figure 2. Two stable orientations of the handles are possible, each providing a different height off the table. In one position the inner handle is forward; in the second, it is to the rear.

It is important that the detents on the handles be engaged when in the tilt-stand position in order to provide maximum stability.

PANEL MOUNTING

The Model 1241 has been provided with an option for mounting on a 1/8 inch panel. Special mounting screws have been provided in the instrument and the panel cut-out dimensions are given in Figure 3.

In mounting the instrument on a prepared panel the circuit board inside the case must be repositioned forward by 1/8 inch. To perform this modification without damage to the instrument the following instructions should be carefully followed. (See Figures 4 and 5)

a. Stand case on back end with inner handle locked in the front position as shown in Figure 4.

b. The front may now be removed. Starting on one side, insert a screwdriver blade, about 1/8 inch, extended through the rectangular hole provided in the inner handle, and into the notch provided in the front assembly. Using the handle as a fulcrum, gently pry the front upwards. It will snap into a new position, 1/8 inch forward. Repeat on the other side. Now reset the screwdriver blade 1/16 inch lower on the front so as to engage the edge of the front assembly, and pry up the front one more notch on each side. The front will now come free.

c. Before pulling off the front, swing the handle clear of the front and reset in the table top position.

d. Facing the instrument's front, gently pull the front forward. The switch shaft may come out with the front. Lay the front down on the table.

e. Remove the shaft from the front and replace it in the rotary switch assembly.

f. The leads may now be removed from the front and the front put aside temporarily. Note the interconnections so as to reconnect correctly. (See Figure 19)

g. The handles may now be removed.

h. To remove the circuit board, rotate the two screws at the rear of the case 1/2 turn

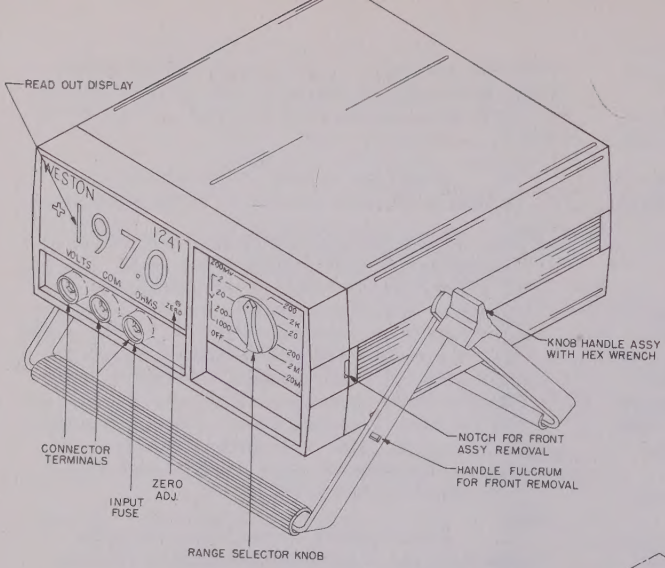

Figure 2. Handle/Stand Assembly

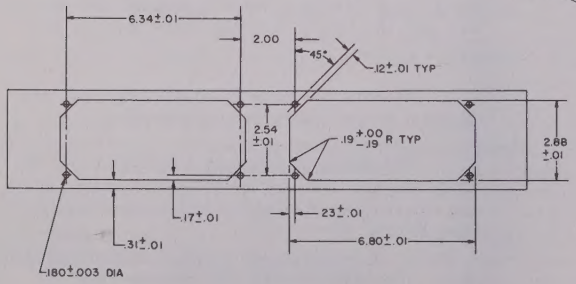

Figure 3. Panel Cut-out Dimensions

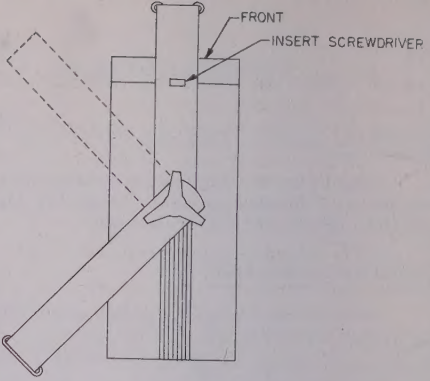

Figure 4. Removal of Front Assembly Using Handle/Stand as Fulcrum

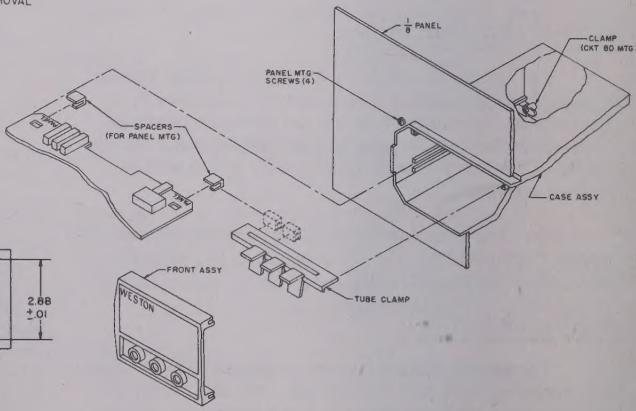

Figure 5. Panel Mounting (optional)

counterclockwise. This will rotate two clamps freeing the board from the case. (See Figure 5) Remove the edge connector guard at this time.

i. Grasp circuit board from the front of the case and remove. This can be assisted by pushing on the rear of the circuit board at the edge of the accessory connector.

j. The board must be advanced 1/8 inch forward in the case to allow for panel mounting clearance. One eighth inch spacers have been provided on the tube clamp. Remove the tube clamp and break off the L shaped spacers at its rear edge. (See Figure 5) Trim spacer edge with razor blade.

k. Slip the spacers onto the rear of the circuit board behind the rectangular cutouts in the space marked PANEL. The spacers should be oriented with the cutout side down. Secure them in place with a small amount of cement such as pliobond. When properly positioned none of the word "Panel" will be visible.

l. The circuit board mounting clamps must now be advanced by 1/8 inch to engage the new position of the cutout. Rotate the clamp screws at the rear counterclockwise about 6 turns until both clamps can be rotated past the stops built into the case.

m. Insert the circuit board into the case making sure that the clamps can slide into the cutouts on the circuit board in this new position.

n. Slide out the circuit board one-third of its length and reinsert the tube clamp in back of the display tubes and into the slides provided within the case.

o. Slide the circuit board all the way back into the case and secure by rotating the screw clamps. Replace edge connector guard.

p. The case may now be mounted into the prepared panel by means of the screws and inserts provided at the front of the case.

q. The leads may now be connected to the front assembly.

r. The front panel may now be reinstalled on the case. Observe that the notch in the range knob lines up with the spline on the switch shaft.

BATTERY PACK OPTION

Instructions for mounting the battery pack accessory are provided with the battery pack. Interconnection will be made through the accessory connector at the rear of the case. When operated without a battery pack the accessory connector must be protected to prevent accidental contact with lethal voltages. A guard has been provided for this purpose and must be kept on the instrument.

POWER REQUIREMENTS

The Weston Model 1241 has been designed to operate on 115 VAC or 230 VAC, 50Hz to 400Hz. A rear panel switch permits operation in either voltage mode. Be sure that the switch is in the proper position for the local power lines before applying power. If 115 VAC is applied in the 230 volt position, only a faint display will occur. If 230 VAC is applied in the 115 VAC position, a rear panel fuse will blow out. The line voltage ratings of this instrument will permit it to extend to 15% above or 10% below nominal line voltage.

The Model 1241 is equipped with a three conductor power cable that grounds the instrument when plugged into a suitable outlet. In addition, the fused side of the power connector will be automatically connected to the high side of the line, on all outlets wired in accordance with U. S. Underwriters Laboratory Standards. To preserve this feature when operating with a two contact outlet, use an adapter and connect the pigtail on the adapter to a suitable ground. Also be sure that the adapter is oriented so as to apply the high side of the line to the fused power input terminal. (See Figure 8, rear panel description for further details).

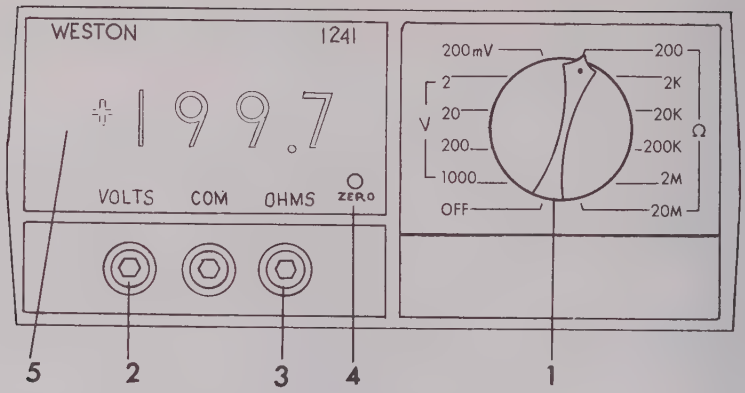

Figure 6. Front Panel Description

OPERATION

1. Range Switch

   a. Applies AC power to instrument. ON is any position but OFF.

   b. Permits range selection for DC Voltage or resistance.

2. Input VOLTS jack (left) and COM jack (center) are inputs for DC volts.

3. Input OHMS jack (right) and COM jack (center) are inputs for resistance measurements.

4. Zero adjustment.

5. Display

   a. Three cold cathode numeral tubes with internal decimal points. Decimal point is automatically determined by the range switch.

   b. An overrange digit to carry thousands digits information. This will either indicate "1" or not at all.

   c. "+" and "-" polarity indicators to automatically indicate polarity of input for DC volts. It reads "+" for resistance measurements.

   d. An overrange lamp indicates an input beyond 1999. It will flick periodically up to 100% overrange and will remain on steadily if the A/D converter is overranged to saturation.

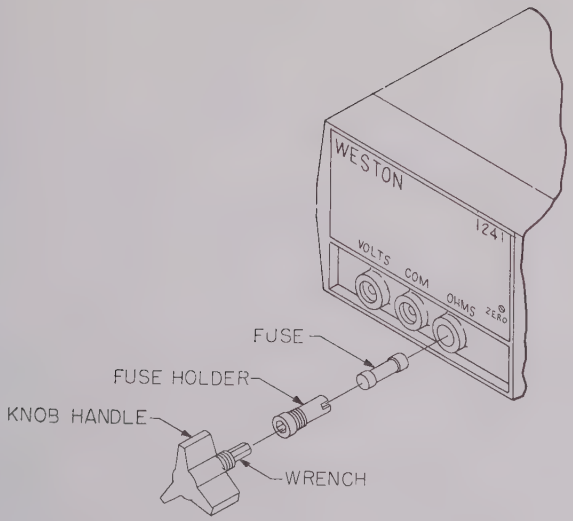

Figure 7. Input Fuse Replacement

All circuits are protected for overloads either through a resistor-diode network, or through fuses which are replaceable from outside of the case. See figure above. A fuse is located behind the OHMS input jack on the case front, a second fuse is located behind the AC line input receptacle in the rear of the case.

All fuses may be reached by removing their fuse holder with wrench on knob handle as follows:

1. Input OHMS jack supports a 3/16 amp. 8AG fuse for protecting instrument input, the constant current source used in resistance measurement. The fuse is removed with a wrench built into the knob handle.

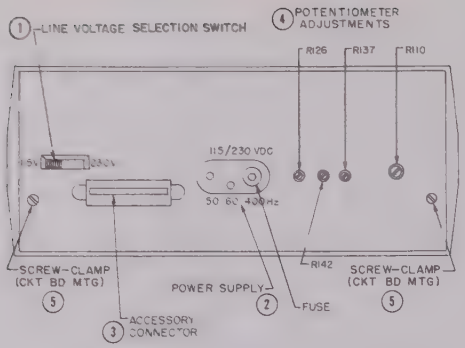

Figure 8. Rear Panel Description

1. Line voltage selector is a two position slide switch. Left position is for 115 volt power line operation. Right position is for 230 volt power line operation.

2. AC Power line connector is a three pin recessed male connector. The right hand pin supports a 1/4 amp. 8AG fuse. It is removed with the aid of the small wrench designed into the tip of the tilt stand knob handle.

3. The accessory connector is provided to accommodate the accessory battery pack. When used without the battery pack, it should remain protected by the insulated cap provided with the instrument.

4. Four adjustments (ohms calibration, +V, -V, 20MΩ) are provided for periodic standardization. See Maintenance Section.

5. Screw-clamps used for securing circuit board.

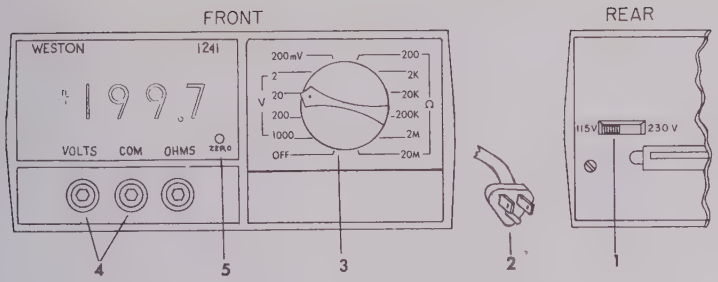

Figure 9. DC Voltage Measurement

1. Set line voltage selector switch on rear panel to proper line voltage position.
2. Plug in power cord to instrument and AC power outlet.
3. Set range switch to 1000 or the desired lower range if known.
4. Connect test leads to the jacks marked VOLTS and COM. Allow 15 minutes warm-up time for stabilization to insure best accuracy.
5. Short test leads and set range switch to 200mV. The display should read zero with polarity indicator flickering between "+" and "-". If not rotate the zero control to achieve this.

NOTE

If the input leads are left open circuited on the 200mV or 2 volt ranges, the display reading will slowly increase due to the presence of a small current appearing across the high input impedance of the converter.

6. Set instrument to 1000V range, apply input and observe reading. If readout exceeds 1000V remove input immediately as overload condition exists. Otherwise, reduce range switch until proper range is reached. Table below indicates proper readout limits for each range.

Range	Proper Readout Limits
200mV	00.0 - 199.9
2V	.199 - 1.999
20V	1.99 - 19.99
200V	19.9 - 199.9
1000V	199 - 1000

NOTE

Unit may be used to 50% overrange on all ranges but 1000V. For example, 220 volts would be displayed as 20.0 plus flashing overrange indicator on the 20 volt range.

CAUTION

Do not float the meter more than 500V above ground or damage to the instrument may result.

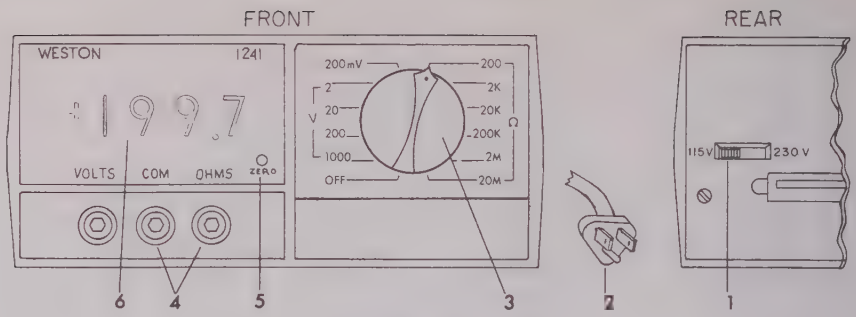

Figure 10. Ohms Measurement

1. Set line voltage selector switch, on rear panel, to proper line voltage position.
2. Plug in power cord to instrument and the AC power outlet.
3. Set range switch to the desired range.
4. Connect test leads to the input jacks marked OHMS and COM. Allow 15 minutes to warm-up for stabilization to insure best accuracy.
5. Short test leads. The display should read zero with polarity indicator flickering between "+" and "-". If not rotate the zero control to achieve this.

NOTE

When using the 200 ohm range, the reading with shorted input test leads may differ from the other ohmic ranges. A small residue of less than one ohm (10 digits) may be indicated due to lead resistance. The user has the option of either subtracting this residue from his measurement of the unknown or nulling the lead resistance out by adjustment of the zero control. If the latter option is taken the meter must be re-zeroed when returning to other ohmic ranges or modes of operation.

6. Connect test leads to unknown resistance and observe reading. Increase or decrease range until proper range is reached. Table below indicates proper readout limits for each range.

Range	Proper Readout Limits
200Ω	00.0 - 199.9
2K	.199 - 1.999
20K	1.99 - 19.99
200K	19.9 - 199.9
2M	.199 - 1.999
20M	1.99 - 19.99

NOTE: Unit may be used to 50% overrange. For example, 270KΩ would be displayed as 70.0 plus flashing overrange indicator on the 200KΩ range.

CAUTION

The resistance measurement circuitry is protected against the application of voltage. The four highest ranges are inherently protected to 250 volts DC or AC by the power dissipation of internal components. The two lowest ranges are clamp diode protected at between 1 and 2 volts and fuse protected beyond this to 250 volts, the rating of the fuse.

THEORY OF OPERATION

INTRODUCTION

This section presents the design and operating principles of the Weston 1241 Digital Volt ohmmeter. The theory of operation is presented at the functional level in the section immediately below and in greater detail on the pages following. Complete schematic diagrams are included for reference in the Maintenance Section.

Model 1241 incorporates all circuitry needed to make measurements of DC Voltage and Resistance.

The basic measuring circuit is a high impedance bipolar analog to digital converter operating on the dual-slope principle. It has a measurement range of either 200 mV or 2 volts DC, depending on the range switch setting. All inputs other than DC volts are converted to DC volts for measurement by this circuit.

Resistance is measured by passing a scaled constant current through the unknown and measuring the DC voltage across it.

The DC voltmeter and the several conversion circuits are interconnected by a complex of function switches and rotary range switches which make possible decimal point switching, input ranging, gain changes in the A/D converter, shared usage of the precision attenuator and a switchable protection function. Rather than present the complete system diagram in the text, with all of its switching complexity, we have elected to present the functional modes, one sub-circuit at a time, indicating the required signal interfaces. Interconnection information is presented in the master schematic diagrams in the maintenance section and the interested user will be better equipped to follow it after first digesting the operating theory of the functional parts.

We have started with the A/D converter, that circuit being basic to all other modes. Then the front-end analog circuitry including attenuator and switching which complete the DC voltmeter circuit. Ohms converter and power supply discussions follow.

The following sections will present the theory of operation of the DC voltmeter and the several conversion circuits.

DETAILED CIRCUIT DESCRIPTION

DC VOLTMETER CIRCUIT

Common to all measuring functions is a high input-impedance, dual slope, bipolar A/D converter. The input voltage may be either 200 mV DC or 2 Volts DC depending on range setting. All the voltages are scaled to one of these ranges by attenuators, shunts, or converters. The display has a maximum reading of 1999 suitably accompanied by decimal points, polarity signs and an overrange display.

The circuit operation will be explained with the aid of Waveforms Figure 11 and the Block Diagram Figure 12.

DUAL SLOPE A/D CONVERSION

Dual slope is an integrating method of A/D conversion which, in common with all integrating techniques, reduces the effect of power-frequency interference on the input of appearing as power supply ripple. Integrating time in the Model 1241 is 200 MS, providing excellent rejection of 50 Hz, 60 Hz and 400 Hz and any other components whose periods are integral submultiples of 200 MS.

The dual slope feature has an added, unique advantage among integrating DVM's. Older systems

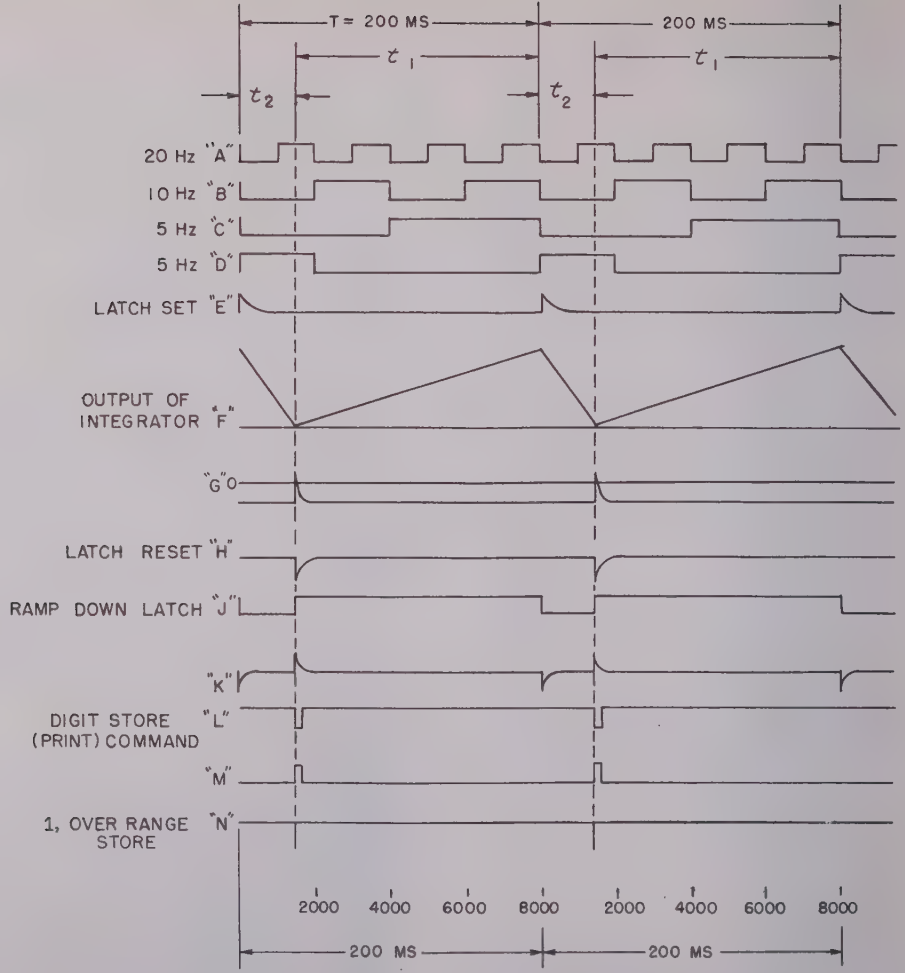

Figure 11. Waveforms

converted amplitude into a time interval then to be digitized by counting the number of clock pulses in that interval. Conversion accuracy was directly dependent on clock accuracy. Dual slope, by contrast, converts amplitude into a ratio of two time intervals, both proportional to clock period and hence independent of clock accuracy.

Figure 11 "F" shows the integrator waveform responsible for this conversion. Integrating cycle time T is constant at 200 milliseconds, corresponding to 8,000 pulses from the 40 KHz clock oscillator. The cycle, is divided into two intervals; ramp up, t_1 and ramp down, t_2.

During t_1 the integrator charges to a voltage $E_{in}\, t_1/RC$. During t_2, the capacitor discharges an equal amount under the influence of E_{in} and I_{REF} such that $\frac{E_{in}\, t_1}{RC} = \left[\frac{I_{REF}}{} - \frac{E_{in}}{R}\right] \frac{t_2}{C}$

Since $t_1 + t_2 = T$, then $t_2 = \frac{E_{in}\, T}{I_{REF}\, R}$

Since the interval T is determined by 8,000 clock pulses and thus lasts 8,000/fc seconds, and the number of clock pulses N in t_2 is t_2 fc, we find that $N = 8000 \frac{E_{in}}{I_{REF} R}$ a quantity independent of fc.

Since the interval t_2 starts at a count of 8,000 (or zero) the count at the end of t_2 is equal to "N" . A storage command at that time transfers the count "N" into display storage.

The conversion process repeats with a new conversion every 200 milliseconds. If the new count is the same as the previous one, the number in storage will not change, and no display flicker results.

The key events in each cycle are the count "8,000" which initiates t_2 by introducing a reference current, and the crossing of zero by the integrator, which terminates t_2 and commands a readout into storage.

DC VOLTMETER - LOGIC SECTION

The analog to digital converter and the 2,000 bit display it generates is under the control of an 8,000 bit timing sequence, (See Figure 12), driven by a 40 KHz clock oscillator. The 40 KHz clock signal drives an 8,000 bit counter chain consisting of 3 decade counters U201, U202, U203 and three binary dividers U213B, U214A, and U214B. Counters U201, U202, and U203 accumulate counts up to 999 and drive three corresponding storage registers. The three binaries register the 1000 count and provide overrange sensing and control functions. Waveforms at the three flip-flops are shown at "A", "B", and "C" of figure 11.

Synchronization

When "B" and "C" simultaneously go to zero, the state "8,000", is detected by coincidence detector U211C. This is a reference condition which occurs only once in 8,000 pulses and is used to start interval t_2. In detecting 8,000, waveform "D" goes from 0 to 1, a transition which sets a control register called Ramp Down Latch (U211A, B.) The Ramp Down Latch occupies a central position in the operation of the converter. When set, producing a negative pulse waveform "J", it permits a reference current to be injected into the integrator, starting interval t_2.

Polarity Display

Simultaneously, the negative transition of "J" triggers Polarity Storage F-F (U215A), causing it to take a state determined by the polarity of the input signal at that time. For the present example, a positive input causes a positive ramp. Therefore, at the onset of t_2, "F" is at its greatest positive value.

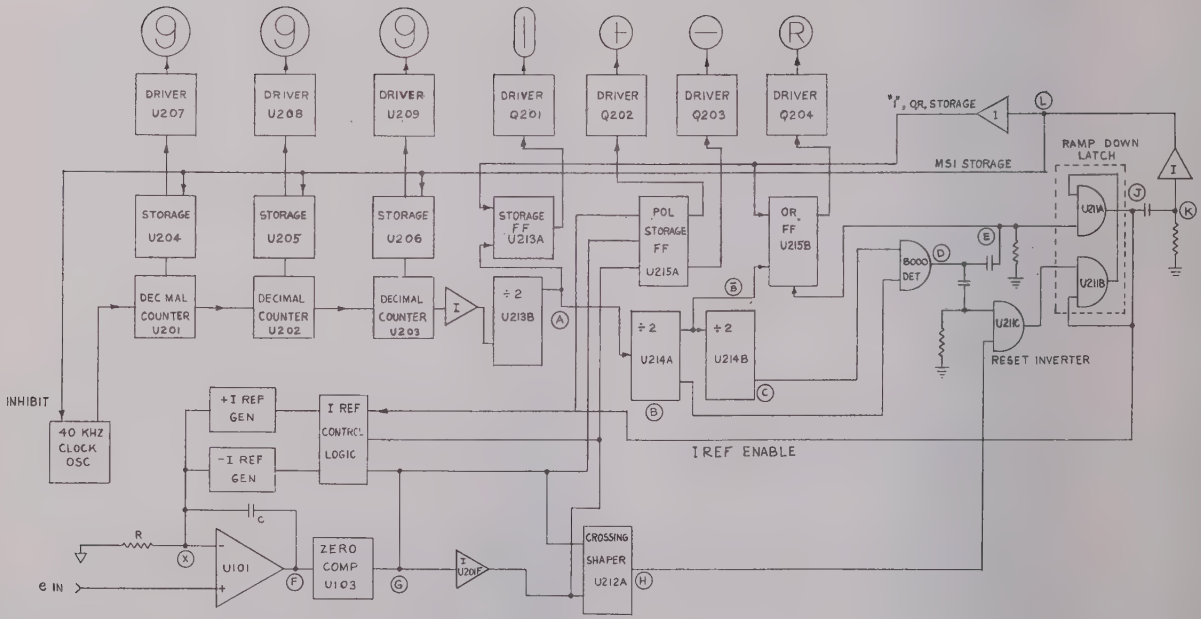

Figure 12. Block Diagram

"G" is negative since U103 inverts. U103 and U210F provide steering inputs to Polarity Store U215A, causing the positive polarity indicator to be set. Polarity indication will remain fixed, unblinking, as long as the input polarity remains the same.

Reference Current Control

During t_2, the "0" state of the Ramp Down Latch enables "I_{REF} control", permitting one of the reference current generators to inject a 400 μa current into the summing junction. The choice of reference current polarity is made by the control logic under control of the steering inputs provided by U103 and U210F. Since input signal polarity is positive, a positive current is injected into the negative input of U101 forcing the integrator back to zero.

Zero Crossing

Interval t_2 ends when the integrator reaches zero. In so doing, the output of zero-comparator U103 undergoes an abrupt positive transition. The resulting waveform generated at "G", is shaped into a negative trigger pulse at "H". (If the input voltage had been negative, a negative transition at "G" would be similarly shaped after inversion by Inverter U210F. Therefore, any zero-crossing is converted into a negative trigger pulse). The zero-crossing trigger pulse at "H" is inverted and applied to reset the Ramp Down Latch. (It will be noted that the positive transition of waveform "D" is coupled over to the reset inverter. This provides a 6 μsec inhibit period which prevents a logical race condition at zero input level.) When the Ramp Down Latch is reset, the resulting positive transition at "J" accomplishes several things, as noted below.

Readout Command

First, it is shaped and inverted into a 1 μsec negative pulse, waveform "L". This commands the storage registers U204, U205, U206 to accept new count information from the decade counters. The count transferred at this time will be the number "N" developed during t_2. The storage registers will remain receptive to changing count data so long as the command pulse is low. Time is thus made available for ripple through of carries which may have started just prior to reset. Also, during the storage command pulse, the clock oscillator is momentarily clamped, preventing any new pulses from entering the counter. At the termination of storage pulse "L", the storage registers are locked up at their new condition and the display tubes they drive remain fixed in display.

The trailing edge of the storage pulse activates two more functions. It commands transfer of the state of the "thousands" counter, U213B, into storage register U213A and triggers overrange Flip-Flop U215B. This register is set to zero (lamp off) at the start of t_2. It will toggle to "1" (lamp on) when triggered, only if both steering inputs are low. This condition, "B" low, will occur after the count of between 2,000 and 4,000, the only stable overrange condition permissible.

For further details of the logic circuitry, refer to Figure 22, Schematic Logic Section, in the Maintenance Section.

DC VOLTMETER-ANALOG SECTION

The previous section described the operation of the A/D converter, with emphasis on the logic section. This section will describe the integrator section, with detailed consideration of biasing, gain switching, and reference current generator circuits. For greater detail and specific component values, refer to Figure 21, Schematic Analog Section, in the Maintenance portion of this manual.

The Non-Inverting Integrator

The basic integrator circuit, shown below, consists of an operational amplifier connected in the non-inverting mode for high-input impedance, and the logic-controlled current source necessary for controlling ramp action, as described in the previous section. The assumption is made that R = 2K, C = 1.75 mf and I_{REF} = ±400 μa. If, for example an input voltage of +100 mV is applied, the feedback amplifier causes point "A" to rise to 100 mV forcing 50 μa through "R". In the absence of a reference current, the 50 μa is provided by the constant-rate charging of C109, and point "B" will rise linearly to support this charge rate.

When, at the count of 8,000, a reference current of 400 μa is switched into point "A", the reference source will supply the 50 μa and the remaining 350 μa will discharge C109. Point "B" will then fall back towards zero at a rate seven times as great as its rise and will take a 1,000 clock bits to do this,* giving rise to a display of 100.0. Other input voltages will give rise to corresponding fall times and displays. For example, a 200 millivolt input would cause 100 μa to flow through "R". A three-to-one time ratio would occur and the display count would be 2,000. In order to scale this converter up to 2 volts, we change "R" to 20K. Now, the 100 μa full scale current requires an input voltage of 2 volts and I_{REF} need not be changed.

Offset Adjustment

Offset voltages in U101, if not compensated, would produce a continuous ramp at B, even with zero input, and the display would stabilize at some small, non-zero reading. To compensate for offset

*Since one complete period 8,000 bits the rise will consume 7,000 and the fall 1,000.

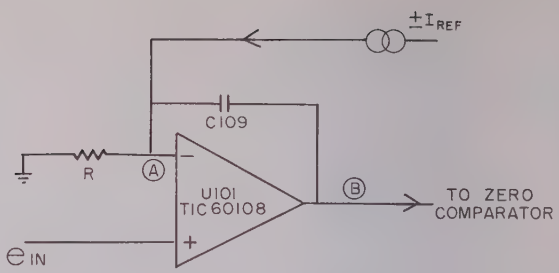

Figure 13. Integrator Circuit

voltage, the ground end of the resistor R is returned to an adjustable voltage, low-impedance, source as shown in Figure 15.

R114 and its associated resistors provide a 10 ohm source, adjustable to ±8 mV to accommodate an 8 mV possible offset voltage in the amplifier. The offset adjustment need not be changed when changing ranges.

Input Attenuation (Figure 14)

On the 200 mV and 2V ranges, E_{in} is applied directly to U101 through a 100 K buffering resistor which both guarantees a minimum balancing source resistance of 100 K and serves to absorb overloads. The 20 V, 200V, and 1 KV ranges make use of a 10 megohm thin film attenuator designed to provide amplifier input voltages of 200 mV or 2V. Since source resistance is constant for all ranges, it can be balanced by a permanent 100K resistor at the inverting input.

The switching of range voltage back and forth between 200 mV and 2 V requires that the resistor in the feedback loop change from 2K to 20K. S102 is arranged to close on the 200 mV and 20 volt ranges.

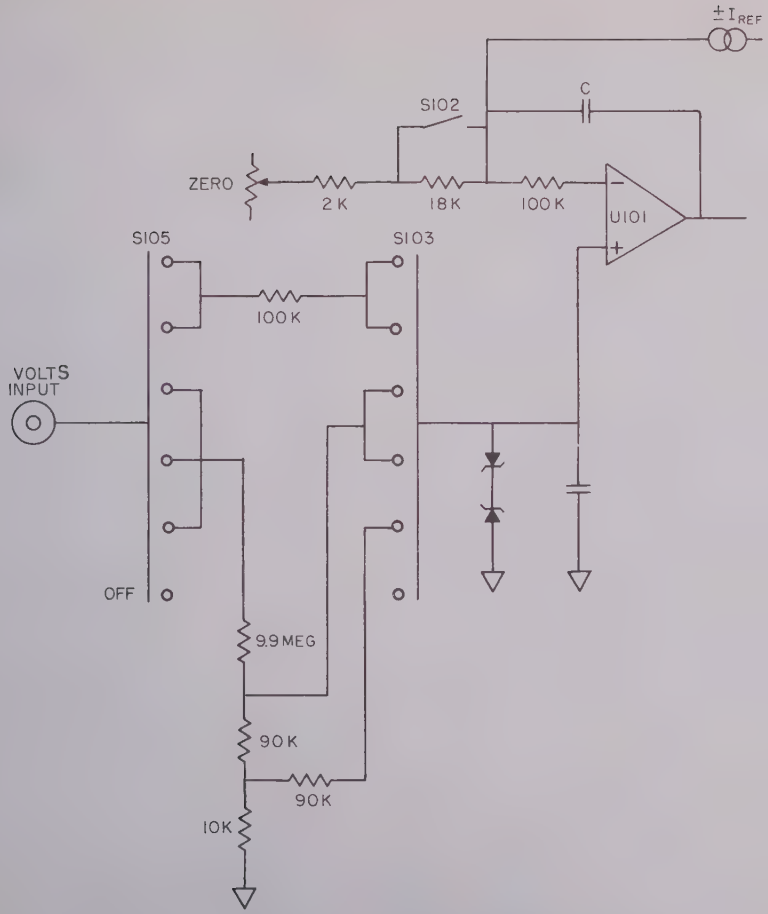

Figure 14. Input Attenuation

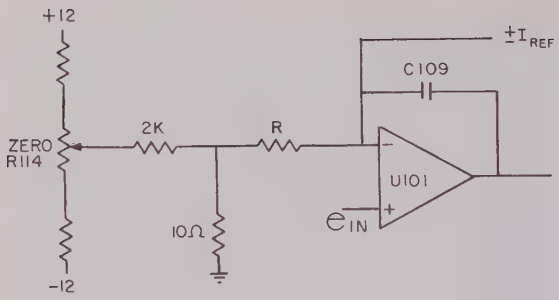

Figure 15. Offset Adjustment

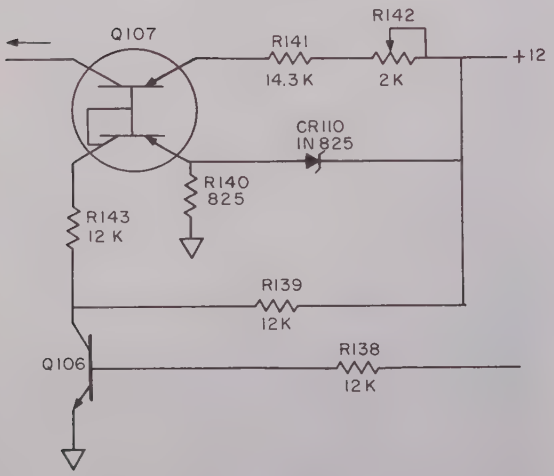

Figure 16. Reference Current Circuit.

Zener diodes and input capacitor are provided for input overload protection and supplementary interference rejection, respectively.

Reference Current Circuits

The reference current generators consist of a common-base transistor constant current source, and is illustrated in Figure 16 for the case of the positive reference.

Q107 is the constant current source controlled, since h_{FE} is high, by the current in its emitter. This current is determined by R141, R142, and the reference voltage of CR110. Since the voltage drops of the two base-emitter junctions of Q107 tend to track, the emitter current will equal almost precisely the zener voltage divided by (R141 +R142). R142 is made variable to compensate for resistor and zener diode tolerance variations, and is adjusted during calibration to provide a reference current (nominally 400 μa) sufficient to display 2000 digits for a full scale input voltage.

R140 is provided to insure that CR110 operates at the 7.5 mA operating point recommended for best temperature stability.

R138, R139, R143, and Q106 provide a means for turning off the reference current by turning off Q106 and biasing off Q107.

OHMS CONVERSION

Resistance is converted to a DC voltage by means of a current source according to the table following. The currents are scaled to produce full-scale voltages of +200 mV on the lower ohms ranges and 2 volts on the three highest ranges.

Range	I source	(Rs) R scale	E(Rx)FS
200 Ω	1 ma	1 K	200 mV
2K	100 μa	10 K	200 mV
20K	10 μa	100 K	200 mV
200K	10 μa	100 K	2 V
2M	1 μa	1 M	2 V
20M	100 na	10 M	2 V

It will be noted that a voltage of 1 volt is maintained across the scaling resistor on all ranges. This is accomplished by a boot-strapping technique as shown in Figure 17.

The voltage developed across Rx, called E(Rx), is applied to the voltmeter input. Because the operational amplifier forces the same voltage to occur at both inputs, we also feed E(Rx) over to the second amplifier U102. A 1 ma current source applied to the inverting input of U102 acts through the associated 1 K resistor to develop an additional 1 volt which adds to E(Rx) producing E(Rx) ±1 V. Since the scaling resistor Rs is connected between the output of U102 and the OHMS input terminal, the voltage across it will be maintained at 1 volt.

The current through Rs is then determined only by Rs as shown in the table above and will be constant independent of Rx. Assuming that negligible current is drawn by amplifier U101 (a practical assumption for most ranges) then the constant current will all flow through Rx creating the voltage to be measured.

Special design considerations which exist at the 200 ohm range and the megohm ranges are treated as follows:

(a) 200 ohms - The nominal value of Rs is 1 K. However, the input protection fuse (included to protect Rs from overload) has about 3.5 ohms cold resistance which could introduce a scale error of 0.35%. The resistor labeled 1 K is actually 996.5 ohms to compensate for the 3.5 ohms. Variations in fuse resistance is not enough to force the instrument out of specification.

(b) 20 Megohms - The 20 meg range makes use of a 10 megohm scaling resistor to produce a 100 na current source. Higher currents would force E(Rx) to unacceptable values. The 100 na is not all available to Rx since up to 10 na of bias current can be drawn by the input of U101. To compensate for this drain, the 10 meg scaling resistor must be reduced and a range of 9 meg to 10 meg can be provided by adjustment of a 1 meg variable resistor.

(c) 2 Megohms - This range, operating on a 1 μa constant current source is susceptible to bias current effects to the extent of 1% of reading. This small error did not warrant a compensation control, but the scaling resistor was decreased from 1 megohm to 996 K to allow for an average value of bias current, the spread of which is sufficiently small to permit the 2 meg range to remain within specification.

Input protection is provided by the fuse and a clamp network. Only the two smallest resistive elements of Z101 are protected since the higher resistance segments have adequate self-protection.

POWER SUPPLY

The power supply circuited for Model 1241 provides a regulated +12 volt source for the analog and reference circuitry, and a regulated 3.6 volt source for the digital circuits. In addition, a half-wave rectifier supplies a 225 volt peak source for the numeral display tubes and neon indicators.

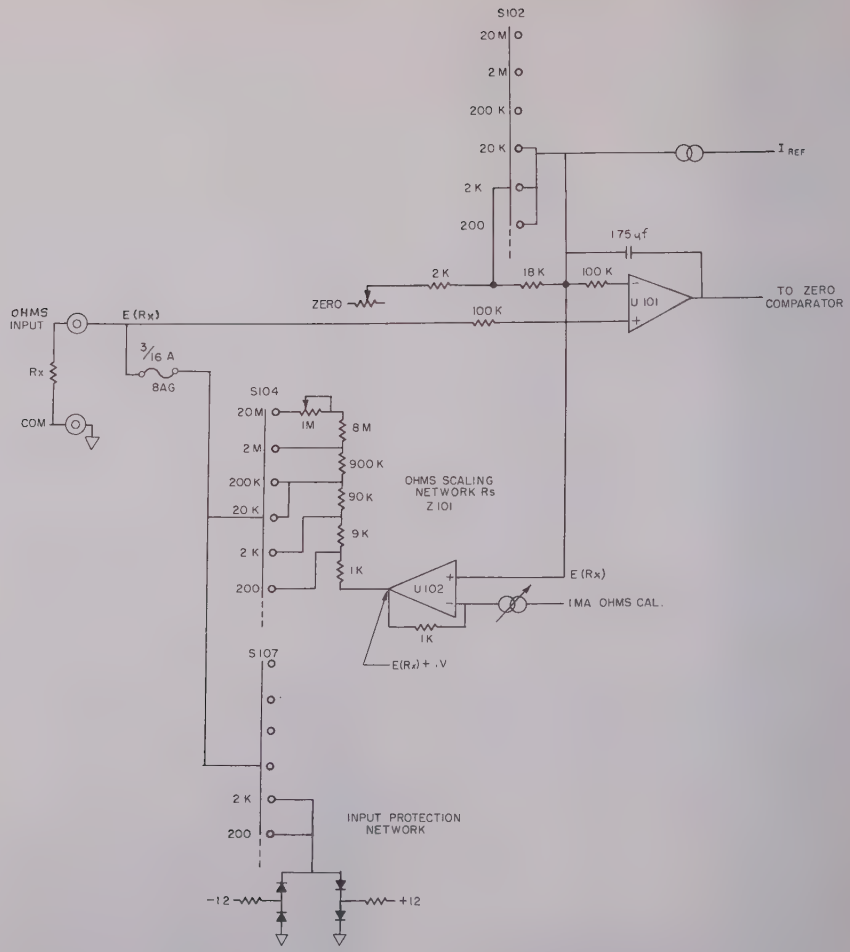

Figure 17. Ohms Conversion Circuit

Pre-Regulation of the current through the 12 volt zener diode is provided to accommodate a +15% to -10% line voltage variations without requiring the excessive power dissipation which resistive regulation would impose.

Two nominal line voltage levels of 115 V and 230 Volts have been accommodated by a switch changing the primary winding connections from parallel to series aiding.

A supplementary winding has been added to the transformer to provide energy for recharging a battery in the battery pack accessory, and to serve as part of the DC to AC Converter, provided with the battery pack. By making the converter winding part of the power transformer, converted battery power automatically replaces AC line power. A schematic diagram of the power supply will be found in Figure 18, in the maintenance section.

MAINTENANCE

In the course of normal operation, the Model 1241 should require no maintenance other than the occassional replacement of indicator lamps or overload protection fuses. Faulty operation may often be traced to improper settings of controls. A brief list of potential symptoms and suggested remedies is in order.

1. Power Fuse blown out - check setting of 115 V/230 V switch on rear panel. If line voltage is 230 volts, the switch should be set accordingly.

2. Half-bright or ill-defined display - rear panel switch may be set to 230 volts on a 115 V AC line.

3. Dim or partially defined digits on one or more indicator tubes - normal wear condition of numeral glow tube. Numeral tubes may be replaced after removing the window, a flexible panel which will be removed and reinserted by curving it about a horizontal axis.

4. Dim neon bulb indicators (+, -, "1", "R")- this is a normal wear condition. Neon indicator may be easily unsoldered for replacement since they are assembled with eyelets. See Installation Panel Mounting for instructions on Front Removal.

5. Runaway display - this is indicative of an open to the input circuit to the A/D Converter, or the situation is a normal result of operating on the two lowest AC or DC voltage ranges. If the test leads are not terminated in a return path the display will escalate uncontrollably. Check the circuit being measured for continuity.

6. Ohms circuit does not respond - check the 3/16 amp fuse behind the Ohms jack. If this has blown, the current source will be cut off from the unknown resistor and no reading will be possible.

TEST EQUIPMENT REQUIRED

The following table lists the test equipment required for checking performance or calibration. It is important to use instruments of adequate accuracy and with a recalibration period sufficient to assure confidence in the results.

TEST EQUIPMENT

EQUIPMENT	PURPOSE	REQUIRED SPECIFICATION
DC Voltage Standard	DC Voltage Calibration	Accuracy: ±0.01% Range: 100mV to 1000V
Resistance Standard	Resistance Calibration	Accuracy: ±0.1% Range: 0.1 ohm to 20 megohm

PERFORMANCE CHECK

To verify the specifications of the Model 1241, the following performance check is recommended.

Where reference standards are required, it is important to use units of adequate accuracy and with a recalibration period sufficient to assure confidence in the results.

DC VOLTAGE ACCURACY CHECK

1. Set the line voltage selector switch on the rear of the instrument for 115 or 230 volt operation as required.

2. Connect power cord to instrument and AC power source.

3. Set range switch to 200 millivolt position.

4. Insert test leads in jacks VOLTS and COM. Allow a warm-up time of approximately 15 minutes to assure best results.

5. With test leads shorted, adjust the zero control on the front until the display reads 00.0 and the polarity lamps flicker back and forth.

6. Set output of DC voltage standard to zero. Connect VOLTS and COM leads on the Model 1241 to (+) and (-) output terminals respectively on voltage standard.

7. Referring to the following table, set voltage standard to output levels tabulated. Set power range switch to its appropriate setting on Model 1241. Check to insure that readout falls within the limits specified, if not refer to the appropriate calibration procedure.

DC VOLTAGE ACCURACY AT REFERENCE CONDITIONS

Voltage Input	Range Switch Setting	Readout Limits	
		Min.	Max.
Input Shorted	200mV	± 00.0	± 00.1
± 01.0		± 00.9	± 01.1
± 10.0		± 09.9	± 10.1
±100.0		± 99.8	±100.2
±200.0		±199.7	R± 00.3
Input Shorted	2V	± .000	± .001
+1.000		± .998	±1.002
+2.000		±1.997	R± .003
+10.00	20V	± 9.98	±10.02
+20.00		±19.97	R± 0.03
+100.0	200V	± 99.8	±100.2
+200.0		±199.7	R± 00.3
+ 500	1000V	± 499	± 501
+1000		± 998	+1002

RESISTANCE ACCURACY CHECK

1. Set the line voltage selector switch on the rear of the instrument for 115 or 230 volt AC line operation as required.

2. Connect power cord to instrument and AC power source.

3. Set range switch to the 2KΩ range.

4. Insert test leads in jacks VOLTS and COM. Allow a warm-up time of approximately 15 minutes to achieve best results before testing.

5. With test leads shorted adjust the zero control on the front until the display reads .000 and the plus and minus lamps flicker back and forth.

NOTE

When checking the 200Ω range for accuracy, it will be necessary to either rezero the meter to compensate for test lead resistance, or to allow for this offset in the accuracy check.

6. Connect meter to resistance standard.

7. Referring to the following table, set resistance standard to values listed. Set Model 1241 range switch to the proper range. Check to insure readout is within the limits given, if not refer to calibration procedure.

RESISTANCE ACCURACY AT REFERENCE CONDITIONS

Resistance Standard	Range Switch Setting	Readout Min.	Limits Max.
.000	2KΩ	.000	.001
1.000KΩ		.994	1.006
2.000KΩ		1.989	R .011
10.00KΩ	20KΩ	9.94	10.06
20.00KΩ		19.89	R 0.11
100.0KΩ	200KΩ	99.4	100.6
200.0KΩ		198.9	R 01.0
1.000MΩ	2MΩ	.994	1.006
2.000MΩ		1.989	R .011
10.00MΩ	20MΩ	9.89	10.11
20.00MΩ		19.79	R 0.21
00.0	200Ω	000	001
100.0		99.4	100.6
200.0		198.9	R 01.1

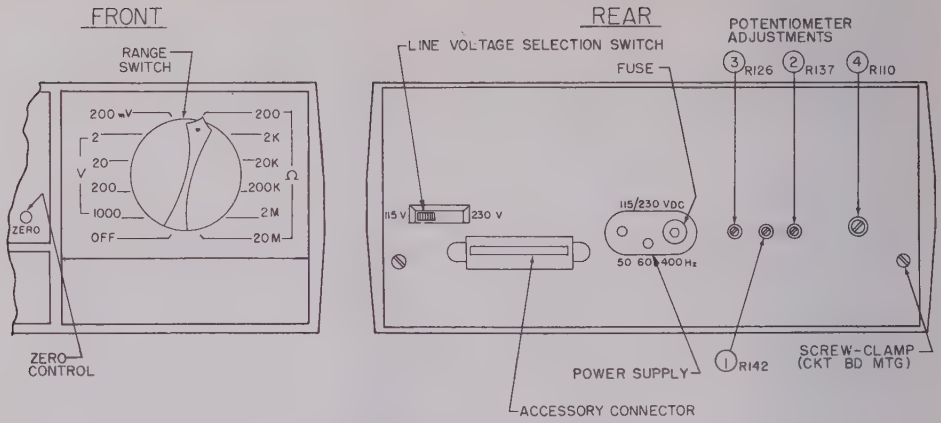

Figure 18. Calibration

If any of the performance checks fail, a recalibration may be required. The starting point of any recalibration is the setting of zero. This should be done on the 200 mV DC range with the input leads shorted. Adjust the front panel zero control for a reading of 00.0 with the polarity signs flickering alternately. Then proceed as follows:

	Range Switch Setting	Input	Adjustment
1	200mV	+200mV	Adjust R142 for readout of +00.0 with overrange "R" flashing.
2	200mV	-200mV	Adjust R137 for readout of -00.0 with overrange "R" flashing.
3	20K	20KΩ	Adjust R126 for readout of 0.00 with overrange "R" flashing.
4	20meg	20mΩ	Adjust R110 for readout of 0.00 with overrange "R" flashing.

SCHMATIC DIAGRAMS AND ASSEMBLY DRAWINGS

This section contains the Schematic Diagrams and Assembly Drawings for the Weston Model 1241 Digital Volt ohmmeter. Reference symbols will be found on either the schematic or wiring diagrams. Item numbers will be found on the Assembly Drawings.

Figure	Description	Page
19	Method of Assembly	26
20	Board Assembly	27
21	Schematic Analog Section	28
22	Schematic Logic Section	29
23	Schematic Power Supply	30

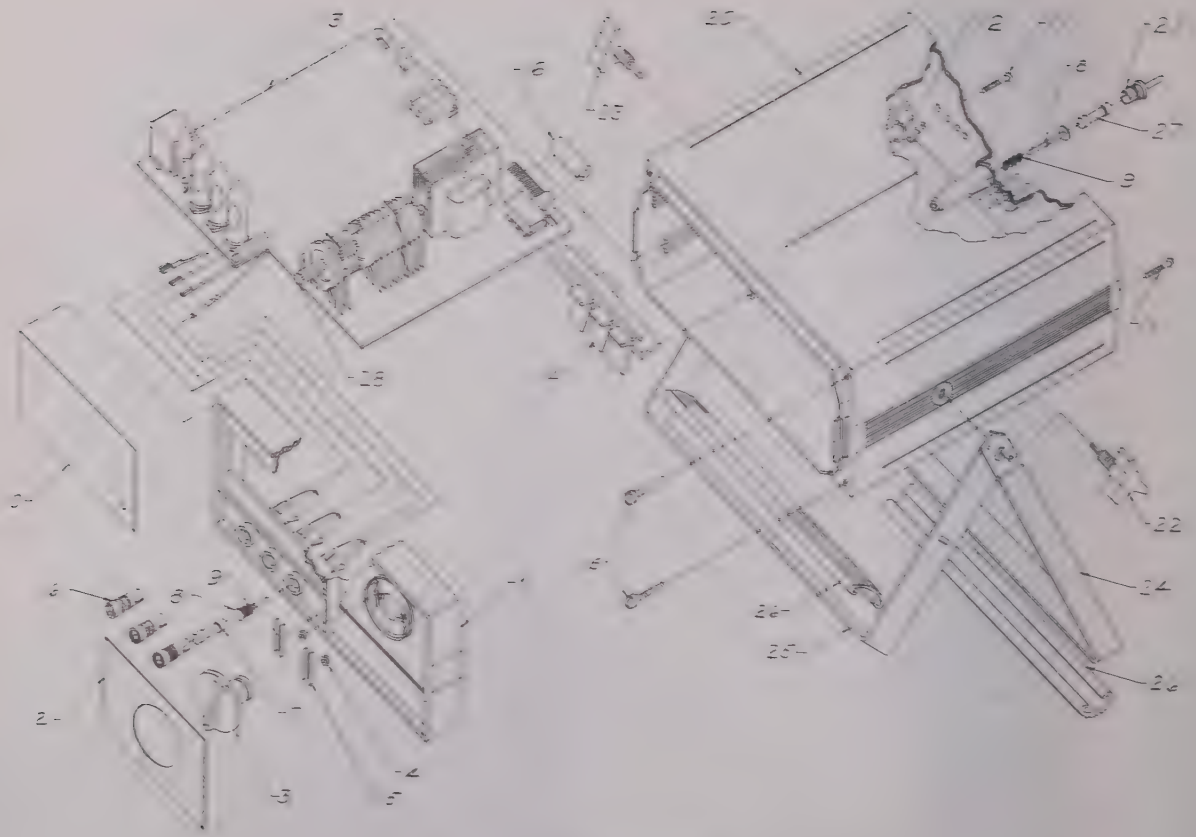

Figure 19. Method of Assembly

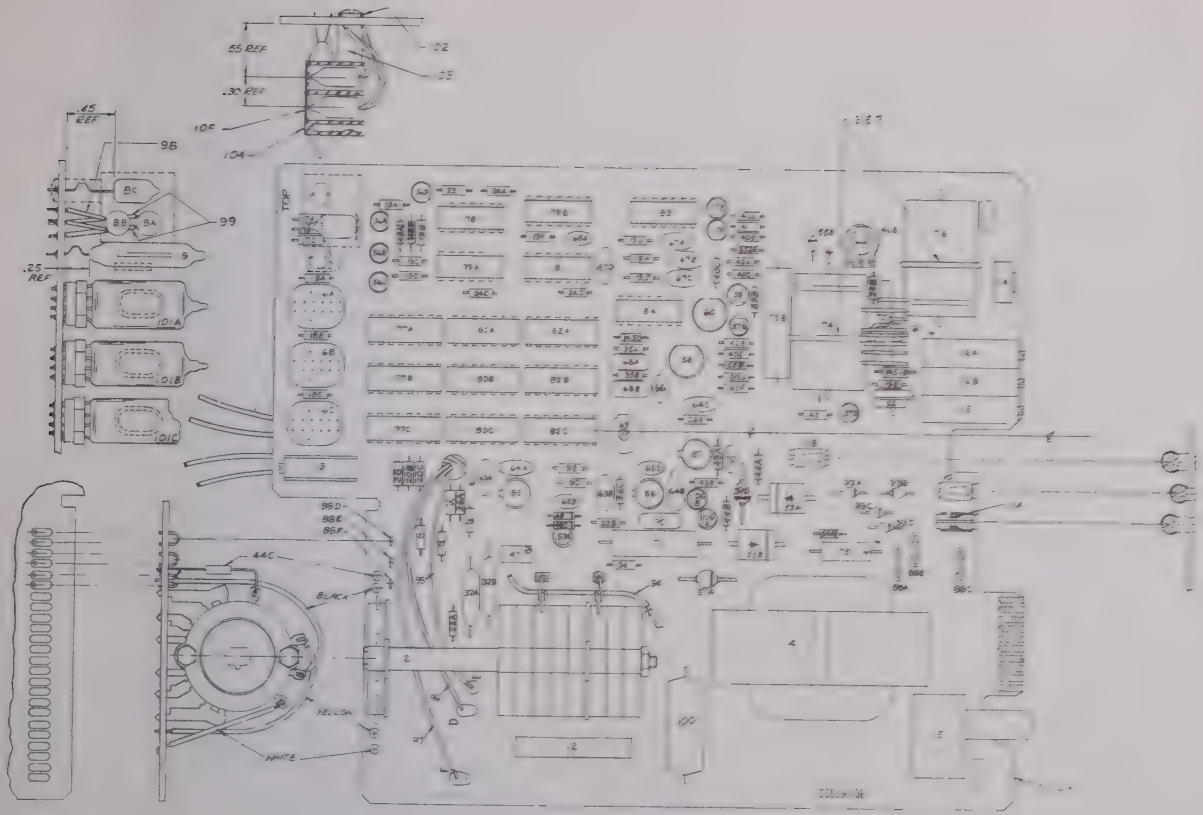

Figure 20. Board Assembly

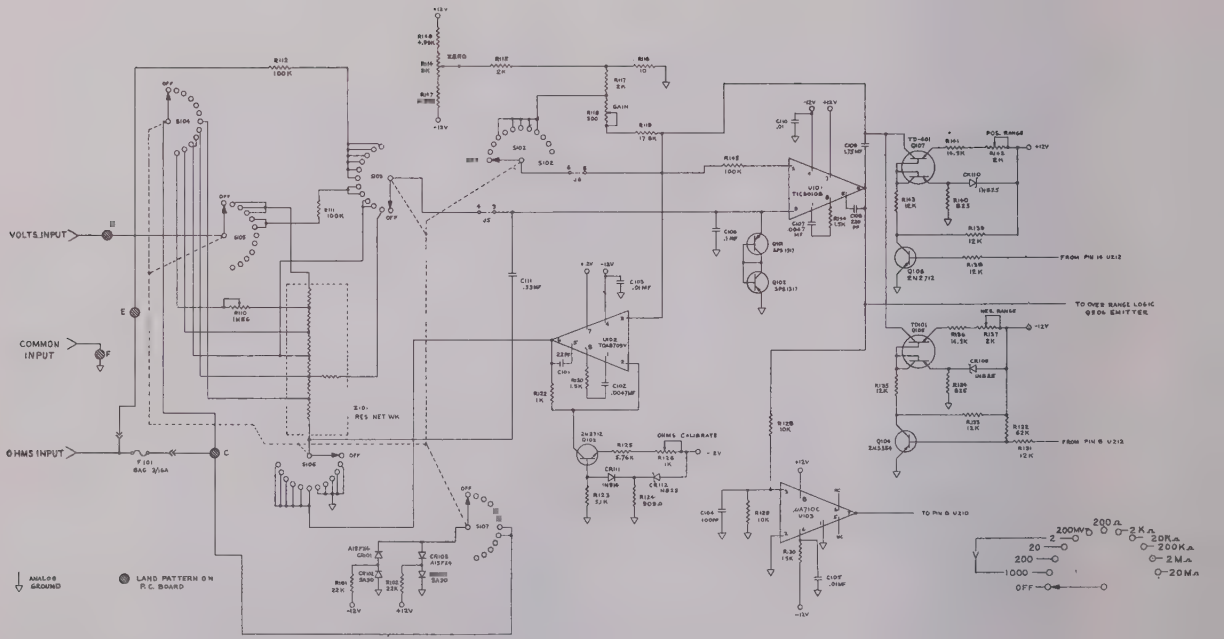

Figure 21. Schematic Analog Section

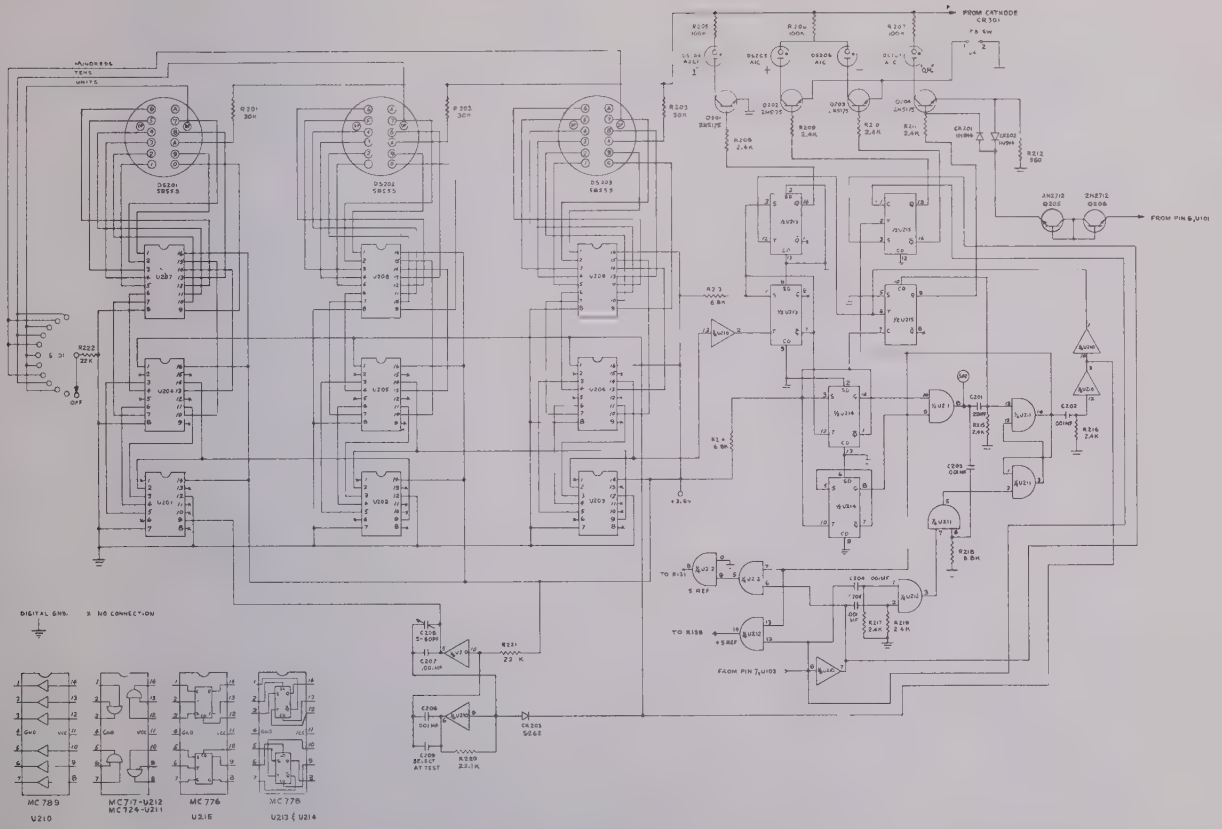

Figure 22. Schematic Logic Section

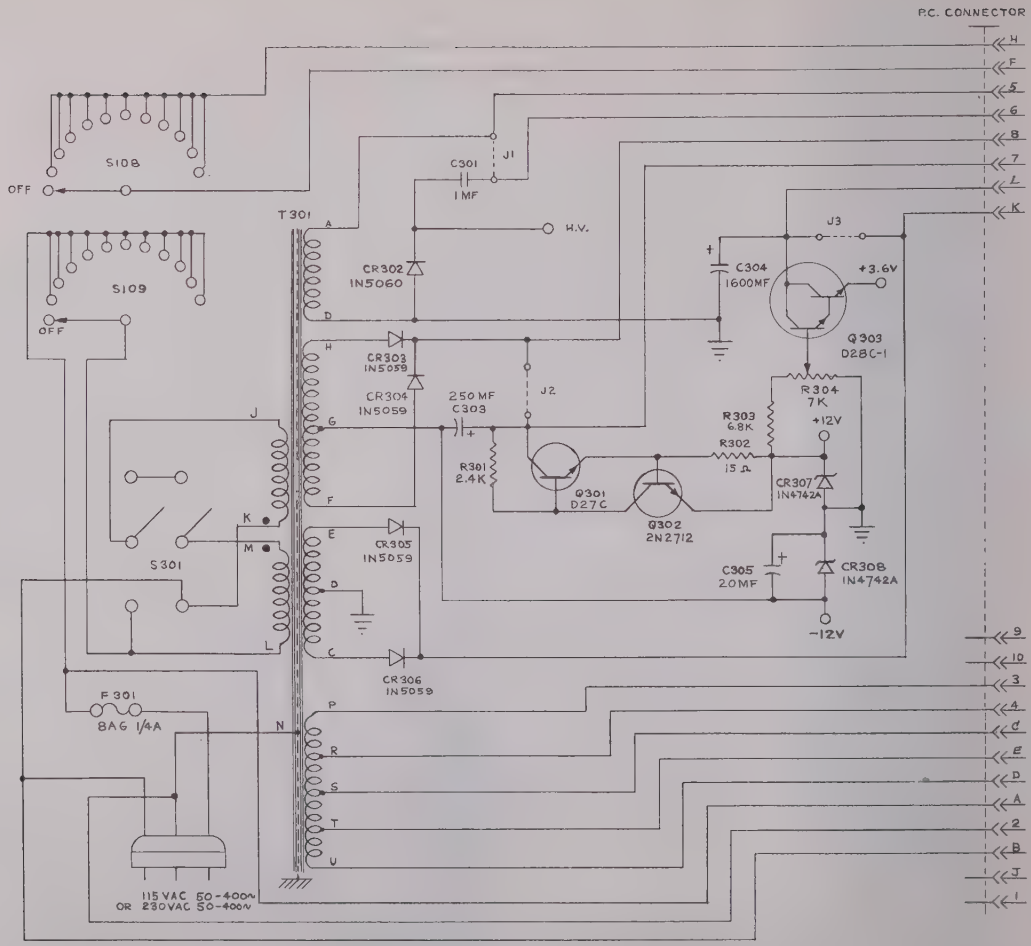

Figure 23. Schematic Power Supply

PARTS LIST
MODEL 1241

REF. SYMBOL	ITEM NO.	DESCRIPTION	WESTON PART NO.
		BOARD ASSEMBLY (Figure 20)	
C101	65B	CAPACITOR, 220pf	264091-001
C108	65D		
C201	65A		
C102	63A	CAPACITOR, .0047 μfd	269898-001
C107	63B		
C103	64A	CAPACITOR, .01 μfd	269899-001
C105	64C		
C110	64B		
C104	72	CAPACITOR, 100 pf	264089-001
C106	70	CAPACITOR, .1 μf	269900-001
C109	71	CAPACITOR, 1.75 μf	269897-001
C202	67C	CAPACITOR, .001 μfd	263666-001
C203	67D		
C204	67B		
C205	67A		
C206	68A	CAPACITOR, 1000 pf	269935-001
C207	68B		
C208	69	CAPACITOR, 5-60 pf	269936-001
C209	66	CAPACITOR, Factory Select	269548-901
C301	73B	CAPACITOR, 1 μfd at 200V	269895-001
C303	74	CAPACITOR, 250 μfd at 64V	266349-001
C304	76	CAPACITOR, 1600 μfd at 10V	266607-001
C305	75	CAPACITOR, 10 μfd at 20V	265800-001
C111	100	CAPACITOR, .33 μf 250V	270038-001
CR101	51B	DIODE, A15FX4	269969-001
CR103	51A		

REF. SYMBOL	ITEM NO.	DESCRIPTION	WESTON PART NO.
		BOARD ASSEMBLY (Cont.)	
CR102	53A	DIODE, 3A30	264724-001
CR104	53B		
CR109	52A	DIODE, 1N825	266309-001
CR110	52B		
CR111	48C	DIODE, 1N914	ND61025-001
CR201	48B		
CR202	48A		
CR112	49	DIODE, 1N823	ND60978-001
CR203	50	DIODE, S262	263643-001
CR302	55B	DIODE, 1N5060	266591-001
CR303	93D	DIODE, 1N5059	266611-001
CR304	93C		
CR305	93B		
CR306	93A		
CR307	54B	DIODE, 1N4742A	264601-001
CR308	54A		
Q101	106A	TRANSISTOR SPS1317	270075-001
Q102	106B		
Q103	57A	TRANSISTOR, 2N2712	ND39917-001
Q205	57E		
Q302	57D		
Q106	57G		
Q206	57F		
Q104	59	TRANSISTOR, 2N5354	268795-001
Q105	60	TRANSISTOR, TD101	266399-001
Q107	58	TRANSISTOR, TD401	269904-001

REF. SYMBOL	ITEM NO.	DESCRIPTION	WESTON PART NO.
		BOARD ASSEMBLY (Cont.)	
Q201	56C	TRANSISTOR, 2N5175	266585-001
Q202	56B		
Q203	56A		
Q204	56D		
Q301	62	TRANSISTOR, D27C	269902-001
Q303	61	TRANSISTOR ASSY	269564-001
R101	44A	RESISTOR, 22K	264674-001
R102	44B		
R222	44C		
R112	32A	RESISTOR, 100K	269912-001
R111	32B		
R145	22B	RESISTOR, 100K	266631-001
R114	13	POTENTIOMETER, 5KΩ	269919-001
R115	28	RESISTOR, 2K	270105-001
R147	20B	RESISTOR, 4.99K	269911-001
R148	20C		
R116	25	RESISTOR, 10Ω	269915-001
R117	21	RESISTOR, 2K	269926-001
R118	47	POTENTIOMETER, 500Ω	269917-001
R119	27	RESISTOR, 17.8K	270074-001
R120	26A	RESISTOR, 1.5K	264677-001
R130	26B		
R144	26C		
R122	29	RESISTOR, 1K	266628-001
R123	92	RESISTOR, 5.1K	ND37341-001
R124	90	RESISTOR, 909Ω	269916-001
R125	36	RESISTOR, 5.76K	269994-001

REF. SYMBOL	ITEM NO.	DESCRIPTION	WESTON PART NO.
		BOARD ASSEMBLY (Cont.)	
R126	15	POTENTIOMETER, 1K	264641-001
R128 R129	43B 43A	RESISTOR, 10K	269887-001
R131 R133 R135 R138 R139 R143	40A 40B 40D 40C 40E 40F	RESISTOR, 12K	266613-001
R132	41	RESISTOR, 62K	263651-001
R134 R140	42A 42B	RESISTOR, 825Ω	269888-001
R136 R141	89B 89A	RESISTOR, 14.3K	269927-001
R137 R142	16A 16B	POTENTIOMETER, 2K	269901-001
R304	46B	POTENTIOMETER, 7KΩ	256087-902
R201 R202 R203	18C 18B 18A	RESISTOR, 30K	269908-001
R205 R206 R207	17C 17B 17A	RESISTOR, 100K	266592-001

REF. SYMBOL	ITEM NO.	DESCRIPTION	WESTON PART NO.
		BOARD ASSEMBLY (Cont.)	
R208	19D		
R209	19C		
R210	19B		
R211	19A		
R215	19F	RESISTOR, 2.4K	266615-001
R216	19J		
R217	19H		
R219	19G		
R301	19E		
R212	23	RESISTOR, 560Ω	269910-001
R213	24C		
R214	24A	RESISTOR, 6.8K	269891-001
R218	24D		
R303	24B		
R220	35A	RESISTOR, 22.1K	269955-001
R221	35B		
R302	45	RESISTOR, 15Ω	269909-001
U101	86	MICROCIRCUIT TIC 60108V	269960-001
U102	85	MICROCIRCUIT TOA8709V	268794-901
U103	87	MICROCIRCUIT UA710C	269903-001
U201	80C		
U202	80B	MICROCIRCUIT CUL 9958	266596-001
U203	80A		
U204	82C		
U205	82B	MICROCIRCUIT CUL 9959	266595-001
U206	82A		

REF. SYMBOL	ITEM NO.	DESCRIPTION	WESTON PART NO.
		BOARD ASSEMBLY (Cont.)	
U207 U208 U209	77C 77B 77A	MICROCIRCUIT CUL 9960	266397-001
U211	81	MICROCIRCUIT MC 724P	264608-001
U210	84	MICORCIRCUIT MC 789P	264612-001
U212	83	MICROCIRCUIT MC 717P	264609-001
U213 U214	79A 79B	MICROCIRCUIT MC778	269921-001
U215	78	MICROCIRCUIT MC 776	269920-001
DS201 DS202 DS203	101A 101B 101C	TUBE, READOUT	266601-001
S1	5	SWITCH, DPDT, SLIDE	269957-001
T301	4	TRANSFORMER	267362-901
DS204	9	BULB, NEON	266537-001
DS205 DS206 DS207	8B 8A 8C	BULB, NEON	ND37710-001
-	12	ATTENUATOR	269078-001

PARTS LIST

MODEL 1241

REF. SYMBOL	ITEM NO.	DESCRIPTION	WESTON PART NO.
		INDICATOR ASSEMBLY (Figure 19)	
-	1	FRONT, MOLDED	267327-902
-	2	DIAL, PRINTED	267356-902
-	3	KNOB, RANGE SELECTOR	267331-901
-	6	SOCKET, BANANA PLUG	267330-077
F101	7	FUSE 3/16 AMP 8AG (OHM INPUT)	269937-001
-	8	CONTACT, BANANA PLUG	269062-001
-	9	SPRING	270006-172
-	10	WINDOW, PRINTED	267328-902
-	11	SCREW (CKT BD MTG)	266623-045
-	12	CLAMP (CKT BD MTG)	265661-024
-	14	TUBE, CLAMP	269437-001
-	15	SCREW, PANEL MTG.	ND32910-024
-	21	PIN, A.C. FUSE	269066-001
-	23	KNOB, HANDLE, Small hex	269546-001
-	22	KNOB, HANDLE, Large hex	269547-001
-	24	HANDLE/STAND, Rear	267346-366
-	25	HANDLE/STAND, Front	267345-366
-	26	GRIP, HANDLE/STAND	267347-902
F301	27	FUSE 1/4 AMP 8AG (A. C. PLUG)	ND29787-001
-	31	GUARD, EDGE CONNECTOR	267351-001
-	-	CABLE, POWER	269985-001
-	-	LEAD, TEST SET	270066-001
-	-	ADAPTER, BLACK CLIP	269997-001
-	-	ADAPTER, RED CLIP	269996-001

WESTON EQUIPMENT WARRANTY

Weston warrants equipment of its manufacture against defective materials or workmanship for a period of one year from date of shipment.

The liability of Seller under this warranty is limited, at Seller's option, solely to repair, replacement with equivalent Weston equipment, at an appropriate credit adjustment not to exceed the original equipment sales price, of equipment returned to the Seller provided that (a) Seller is promptly notified in writing by Buyer upon discovery of defects, (b) Upon receipt of written authorization from Seller the defective equipment is returned as directed, transportation charges prepaid by Buyer, and, (c) Seller's examination of such equipment discloses to his satisfaction that defects were not caused by negligence, misuse, improper installation, accident, or unauthorized repair or alteration by the Buyer. Any modification such as changing range resistors may void this warranty.

This warranty does not include mechanical parts failing from normal usage nor does it cover limited life electrical components which deteriorate with age such as tubes, lamps, etc.

This warranty is in lieu of all other warranties, expressed or implied, including the implied warranty of fitness for a particular purpose to the original purchaser or to any other person. Seller shall not be liable for consequential damages of any kind.

The aforementioned provisions do not extend the original warranty period of any article which has been either repaired or replaced by Seller.

www.manualsplus.com
1028220